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FOREST PLANTATIONS

in

NORTHWESTERN PENNSYLVANIA 2.5403



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ALLEGHENY FOREST EXPERIMENT STATION*

Occasional Paper No. 3 U. S. Forest Service Philadelphia, Pa. April 15, 1941

FOREST PLANTATIONS IN NORTHWESTERN PENNSYLVANIA

by J. E. Hetzel, Junior Forester

During the past 40 years a total of approximately 222,000 acres have been planted to forest trees throughout Pennsylvania. More than one-half, or 130,000 acres of this total, was planted during the 11 year period 1928-1940. Plantations classed as successful covered 170,000 acres in 1939, or about 76 percent of the total area planted. At the present rate of nursery production and planting (an average of 11,000 acres per year), it will take 136 years to plant up the 1,500,000 acres of idle land estimated to be suited to reforestation.

The present and possible future planting program is large; therefore important benefits from advances in technique which will insure greater field survival and better choice of tree species for given sites are to be anticipated.

Past reforestation efforts in northwestern Pennsylvania have, in turn, featured the use of white pine. Scotch pine, and red pine. Norway spruce has been in general favor over the last four decades, but has occupied a secondary place in the program. Other native and introduced spruces, pines, larches, hemlock, and the hardwoods have fluctuated in popularity but have been planted in minor numbers.

At the present time there is a need for a general review of the question of what species to plant and where they should be planted. Does a detailed examination of past red pine plantations reveal any weakness in this species likely to place it in a "doubtful" or hazardous class, along with white pine and Scotch pine? Can a greater use be successfully made of the various native hardwoods? Which of the commonly planted tree species is relatively more successful in producing well-formed trees of good height and diameter growth in older plantations?

To answer some of the above questions, an examination was made of 73 older plantations, limited for the sake of uniformity to those made on old fields, pastures, or other cleared lands. This survey

1/ Meek, C. R. 1932. The idle land problem in Pennsylvania. Service Letter, Penna. Dept. Forests and Waters. Series 3, No. 482.

^{*} In cooperation with the University of Pennsylvania.

was made in 1939 by the Station in cooperation with the Pennsylvania Department of Forests and Waters. These plantations represent the more successful early plantings made in both the "Northwestern Glaciated" and the "High Plateaus" sections of the northern Allegheny Plateau at elevations of 1,000 feet or more. With a few exceptions they were 20 years or more in total age from seed. Many were on private land in farm ownership though some had been made on abandoned fields in the State Forest, and practically all had shown good initial survival and were fairly well stocked at the present time.

Preliminary selection of plantations to be visited was made from records of nursery stock shipments made prior to 1920, on file at the District Forester's offices. The attempt was made to secure a representative cross-section of the territory covered, for as wide a variety of species as possible. In approximately one out of three shipments traced in the field no further records were available due to subsequent failure of the stock to survive after planting.2/ The 73 plantations were located and field measurements secured with the aid of personnel made available by the District Foresters of the Susquenannock. Kittanning, and Cornplanter Districts.3/ Detailed records of the location, elevation, age, original spacing, survival, vigor, soil and litter conditions, and tree measurements by species were kept for each plantation. A partial summary of these data is given in the attached table.

Results of Study

The results of this study show that red pine generally had the best survival, was the best formed species, and grew best in diameter, when compared with each other species. 4/ It was, however, surpassed by jack pine, European and Japanese larch, in average

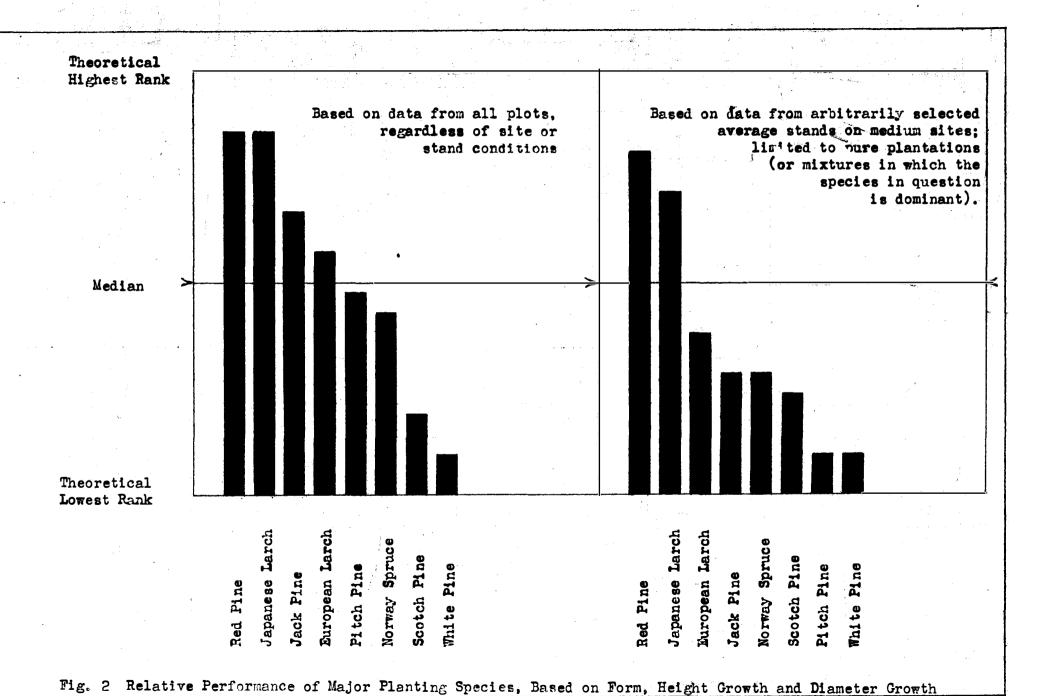
- 2/ Various causes of failure were found: grazing by cattle, excessive weevil damage, brush competition, fire, theft, and improper planting. In general, it was almost impossible to obtain complete information as to origin of seed, nursery from which shipped, ageclass of stock, method of planting, or site and weather conditions at the time of planting, though efforts to talk with the original owners and planters were made.
- 3/ The writer wishes to express his appreciation to Messrs. Paul Duck, Chester Lilly and R. A. McKie of the above Districts for their assistance in the field, and to their respective District Foresters for their cooperation in making such assistance possible.
- 4/ Previous surveys of young plantations on Allegheny National Forest by the Station have already shown red pine to be the most successful in survival on all except the wet sites.

annual height growth (Figure 1). The superior form of red pine was evident in all plantations measured and was observed in many others inspected throughout the entire area of northwestern Pennsylvania.

Since these are picked plantations in which certain species have survived successfully, or with fair success, for a number of years, it is best to discount the figures of estimated present survival, in evaluating the relative performance of each. In these older successful plantations the quality and growth rate of the individual stems sampled seems to be a better measure of the capacity of the given species to produce useful products and to reach maturity. $\frac{5}{}$ A relative performance index based on these qualities was computed for each species and is shown graphically in Figure 2 for the eight species most commonly planted. The indexes are computed separately for all plots and for a representative group of plots on well-drained sites in which a single species was planted or in which a mixture was dominated by a single species. The basis for this theoretical rank of low to high makes use of three criteria. (1) form, (2) height growth, and (3) diameter growth, each of which has been given equal weight. The superiority of red pine and Japanese larch is indicated in both graphs. Jack pine and European larch follow, though interchanging positions in the two graphs. Pitch pine dropped to seventh place in the selected group of plots due to the elimination of stands on better than average sites.

Before a final choice of species to be planted is made, the indications obtained from Figures 1 and 2 must be supplemented by information on the size of stock required for early survival, site and competitive conditions in the area to be planted, and the relative susceptibility of the young growth stages to climatic and biotic damage. While Japanese larch ranks with red pine in growth and form, it is, like European larch, readily damaged by frost and much less successful from the standpoint of early survival. Norway spruce makes a relatively poor showing in Figure 2 due to the fact that most of the plantations sampled were mixtures in which it was seriously crowded. Even white pine and Scotch pine are more nearly the equal of the other conifers if stems of medium as well as good form are included. Damage to the form of white pine caused by repeated weeviling can be greatly reduced by means of close spacing and mixed planting. Present day white pine plantings in northwestern Pennsylvania have, however, all too often been unsuccessful due to competition with more rapidly growing associates in mixed plantations and to hardwood and brush competition on old burns. Browsing by deer and rabbits and injury by domestic stock, in addition to severe weevil damage, frequently result in poor survival and inferior form of the surviving trees. Protection from the white pine blister rust is also essential.

5/ Morey, 1935, has devised a so-called "Success Index" for young forest plantations, under 15 years of age, in which total age, total height, and percent survival are used as criteria of success, but this is not applicable to older plantations. Technical Note No. 16. Northeastern Forest Experiment Station.



Only a few plantations of rarely planted species such as Japanese red and black pine, northern white-cedar, and various native hardwood species were found. These are listed in the partial summary of plot data in the attached table and will be given but brief mention. With one exception, shown in Figure 4, the Japanese pines were of poor form and cannot be recommended for field planting, except on an experimental basis, until more is known as to seed sources adapted to American conditions. Northern white-cedar (Arborvitae) was a failure in the one plantation encountered.

Success of Hardwood Species

One plantation each of sugar maple, yellow poplar, red oak, black locust, black walnut, and two of white ash were located. Few of these were successful in terms of good form, though the growth rate of black walnut compares favorably with that of the conifers. Yellow poplar mixed with European larch on a very favorable site has held its own and is now in excellent condition as to spacing and thriftiness. Soil building processes are very active in this plantation. The black locust on the Fox Estate near Foxburg, Pennsylvania, was planted in 1860 and developed into a thrifty stand, yielding occasional timbers for a nearby oil lease, but is now an open decadent stand (Figure 5) subject to borer attack.

White ash has been rather widely planted for several decades, but failures greatly outnumber the successful plantations. Plot 72 demonstrates the possibility of establishing white ash in mixture with conifers on relatively frost-free sites. On Allegheny National Forest past experience has shown that white ash cannot be used successfully on exposed sites where conifers thrive. Red oak is less damaged by frost and grows well as shown by Plot 59.

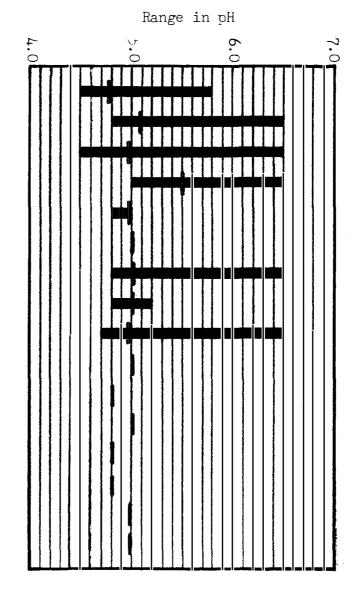
Soil Conditions in Plantations

Conifers planted on cleared ground for a number of years had developed distinct needle litter and humus profiles, in some cases tending toward an earthworm mull on the better sites. All except a few plots were on well-drained soils varying in texture from clay loams and silt loams to fine sandy or gravelly loams and stony loams. A colorometric test of pH was made for the upper mineral soil at depths of 6 to 8 inches for various tree species planted. It is evident that the conifers are tolerant of a rather wide range of pH values as shown by Figure 3. Soil acidities generally center around pH 5.0 for all species. Averages were obtained by converting pH values to specific acidity as outlined by Wherry, 1922.6/

6/ Wherry, E. T. 1922. Soil acidity and a field method for its measurement. Ecology 1:160-173.

3. The pH Reaction of Soils in Plantations

| Red Pine | 7 |
|---------------------|----|
| Scotch Pine | 11 |
| White Pine | 13 |
| Pitch Pine | 4 |
| Jack Pine | 3 |
| Japanese Black Pine | 1 |
| European Larch | 10 |
| Japanese Larch | 3 |
| Norway Spruce | 13 |
| Arbor Vitae | 1 |
| Sugar Maple | 1 |
| Yellow Poplar | 1 |
| White Ash | 2 |
| Red Oak | 1 |
| Black Locust | 1 |
| Black Walnut | 1. |



Mixed Versus Pure Plantations

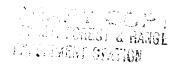
During the course of this survey certain observations on species development in row mixtures and in small pure blocks indicate the latter to be preferable as a planting method. Due to differences in growth rate of various species and the fact that a given site is seldom equally favorable to two or more species it is inevitable that, as the crowns close, one species will dominate the other if they are planted in alternate rows or other stemwise mixtures. The alternate suppressed rows, which as a rule drop out fairly early, leave an undesirable oblong spacing of the dominants and add nothing in the way of marketable thinnings. Block mixtures would avoid this extra cost of planting and loss of planting material and, at the same time, if kept to a reasonably small size will avoid the hazards of large pure plantations.

Conclusions

It is evident that, on the old field and other cleared sites studied, the conifers as a class are much more successful in producing desirable forest plantations than the hardwoods. Red pine has made an excellent record in these older plantations and is to be recommended above other commonly planted species for use on open upland sites in northwestern Pennsylvania. On frost free sites the larches offer promise of rapid and successful development. Two hard pines, jack and pitch pine, grow on both fertile and depleted agricultural soils and can be used with reasonable assurance of success. Norway spruce, despite its slow initial growth as compared to the pines, is a desirable planting species judging from the high survival, good vigor, and excellent form of trees sampled in older plantations of northwestern Pennsylvania.

Until more successful planting techniques are devised and seedlings of known seed sources capable of quality growth under given climatic conditions are available, it will probably be best to confine the planting of Scotch pine, and the various hardwood species studied, to small areas on an experimental basis.

White pine was formerly the most valuable conifer in this part of the State and grew well when natural reproduction got a start after catastrophes in the virgin forest. The present study shows it to be inferior to other species in growth and form when planted on old field sites. Continued experimentation is necessary to determine how best to protect white pine from weevil and to secure successful natural pruning, while at the same time maintaining growth rates sufficiently to prevent suppression by associates. Though white pine cannot be recommended for large scale planting, either on abandoned fields or old burns, on the showing made by these older plantations, it is a species well worth continued efforts to devise successful means for propagation and development in both plantations and natural old field stands.



PARTIAL SUMMARY OF PLOT DATA

| | | | | | | | 1 | _ | _ | | 1 | Crown Clase | | | Tors | | | eht (ft. | Т Т. | | D. | b. h. | b. h. (in.) | | | | [| | | Needle Litter (H) Humus (H) Partially | | |
|---------------------|----------------------|-------------------------------------|---|--------------------------------|----------------------|----------------------|-------------------------------------|----------------|-----------------------------|------------------------|-------------|-----------------|-------|------------------|-----------------------|---------------|---|----------------------|----------------------|-------------------|------------------------|-------------------|---------------------------------|------------------------------------|-----------------------------|-------------------|----------------------|---|------------------------|--|--|--|
| Plo | | Species | Locat | tion | Elev. Above | Ace | Original | Bo. | Zat. | | - | Crown CIA | | + | 70. | - | | TAV. | <u> </u> | •Av. An. | from | | | AV. A | . A | innual : | *Dev. from | 8 (| 11 | | Rusus (E) Partially Decomposed Litter (F) Brush (B) and | REMARKS |
| No. | , | Species | Town | County | Lovel | From Seed | Original Spacing (ft.) | | Pres. Sur- | Vigor, Condi- | No. Don. | No. N Co-D I | | o. Ma pens Go | od Med. | Foor | Max. Min. | G.C. | *AT. | Heigh Growt | t Sp. th Av. (≸) | Max. | | | a C D | Growth . | Sp. ↓ Av. (\$) | Kind | Drain- | рB | Herbaceoue Cover (V) (absent except as noted) | Initial letter indicates whather mixed (M) or pure (P) planting. |
| | | | | (4) | (ft.) (5) | (years) | (7) | (5) | (9) | \$ tion (10) | 1 | (12) (| 13) (| 24) (1 | E) (16) | (17) | (18) (10 |) (20) | (21) | (55) | (23) | (54) | (25) | (26) (| 27) | | (29) | (30) | (31) | (32 |) (33) | (34) |
| · ···· (| | (2) | (3) Auetin. | Potter | 1600 | 24 | 7 = 14 | 25 | 90 | Excellent | | | 3 | | 2 2 | | 40.0 29.1 | | | | | | | 7.9 9 | | .38 | +41 | Stony loam | V. Good | | 13° N, 3° E | M-Formerly cult., grazed. 3 rows WP 3\frac{1}{2}x3\frac{1}{2} betw.RP rows. |
| | 51 Re | d pine | Condersport | Potter | 1700 | 22 | 6 x 6 | 25 10 | 85 | Excellent | _ | 25 | _ | - 8 | 4 1 | | | | 32.1 | 1.5 | +15 | 7.7 | 4.0 4.5 | 5.9 5 | i.9 | .27 .26 | | Gravelly loam | V. Good | 4.8 | 13° H, 13° F. 0-2° H | M-Deteriorated site. |
| | 24 Re 26 Re | d pine | Girard Hartstown | Erie Crawford | 937 1152 1442 | 23 22 | 4 x 4 5 x 5 4 x 4 | 10 20 20 | 85 80 | Excellent Good | = | 10 20 17 | - | - 1 | 9 1 | ī | 37.1 26.9 28.9 25.0 28.7 21.3 38.0 26.9 29.6 22.1 | 27.3 | 27.3 | 1.5 1.2 1.2 | - 8 - 8 | 7.3 1.5 6.7 | 3.3 | 5.6 5 | j . 6 | .25 . | - 7 | Fine sandy loam Silty clay loam Fine sandy loam | Good Good V.Good | 5.8 5.0 4.8 | 13" N, 13" F, 0-2" H 13" N, 3" F, 13" H 14" N, 5" F, 0-2" H 14" N, 5" F, 0-2" H 3/4"N,2"F,1"E,0ccas.WA | M-Dese fertile soil. M-Dense standingury from roosting birds; homus pg 4.0. |
| 1 | L7 Re | nd pine nd pine | Townwille Polk | Crawford Venango | 1442 1150 | 22 19 | 6 x 6 | 20 20 | 75 98 | Good Excellent | - | 20 | - | - i | 8 2 | Ξ | 29.6 22.1 | 32.0 26.5 | 32.3 26.5 | 1.5 | +15 + 8 | 7.0 | | - | j . 4 | .25 . | | Fine sandy loam | Good | 4.5 | | M-Occasional BO, BC reproduction. M-Pruned to 9' about 1937; dominates inter-planted WP rows. |
| | 3 Re | ed pine | Polk | Venango | 1400 | 14 | 6 z 6 | 20 | 90 | Excellent | 10 | 10 | - | - 1 | eo - | - | 16.6 11.1 | | 14.2 | | -23 | 4.6 | 1.7 | 2.7 2 | | - | - | Fine sandy loan | Good | | 2"-3/4"H; elow decomp. | M-Formerly in pasture. |
| 1 | 10 Sc 12 Sc | otch pine | Condersport Bruin | Potter Butler | 2260 1400 | 27 26 | 4 x 44} 3 x 3 | 15 20 | 60 149 60 85 80 | Fair Good Poor | -8 | 14 10 | 2 | 1 | 1 g 8 9 | 6 | 29.2 22.1 42.1 26.1 | | 26.0 37.2 | 1.4 | -10 +40 | 7.5 | 4.2 3.6 2.7 | 5.8 5 5.4 5 4.9 4 | i.6 i.6 | .22 | +1Ó | Stony sandy loan Gravelly sandy la | Good Good Fair | 5.0 5.5 5.8 | 3 N.3 P | M.Humms development barely noticeable. M.Formerly in pasture. M.Silt and shale base soil. |
| . 1 | 15 Sc 23 Sc | otch pine | Condersport Girard | Potter Erie | 1800 937 | 24 23 24 | 4 x 4 | 20 20 12 | 60 85 | Excellent | _ | 19 12 | 1 | - | 5 7 | 17 10 | 28.6 18.1 30.1 24.1 27.2 18.1 | 27.1 | 24.1 27.1 23.2 | 1.0 | 0 +20 =10 | 6.9 6.6 | 3.5 3.0 3.3 | | | .20 .23 | +15 | Stony silt loam Fine sandy loam Oravelly loam | Good V.Good | 5.8 | 3/4"N,earthem mull,lt.B 12"N, 3"F, 12"H 3/4"N, 3"F, 2"H 12"N, 3"F, 2"H; med.decomp. | M-Dilt and shale base soil. M-Deep fertile soil; loose mull structure. M-Dateriorated site. |
| | 29 84 | ootch pine | Coudersport Eartstown Franklin | Potter Crawford | 1720 1152 1300 | 24 23 12 to 17 | 5 x 5 5 x 5 6 x 6 | 25 20 20 | 80 80 No | Poor Poor Good | = | 25 19 | ī. | - 20 Te | - 15 9 11 dr to | 2004 | 27.2 18.5 31.3 23.1 12.0 | 26.8 | 26.9 | 0.9 1.2 0.7 | +20 -30 | 5.1 | 3.3 | 4.2 4 | 3 | | - ś | Silty clay loam | Fair | 5.0 | la"N, a"F, a"H; med.decomp. Light leaf litter, sarthwm. | M-Fidures replaced currently.Light overstory of oak. |
| | - | cotch pine | | Venango | 1500 | , | 4 = 6 | | 78 | | - | - | | - 1 | | | | | at a | 1.1 | +10 | | 25 | 4.0 ¥ | | .20 | 0 | Fine sandy lean | Good | | mull. | Growth rate based on whorl count and height. |
| | 6 8 0 | etch pine etch pine etch pine | Foxburg Polk Kittenning | Clarion Venango Armetron | 1100 | 22 18 16 | 6 x 6 | 22 20 20 | 87 84 | V.Good Good | 6 | 14 20 | : | : ' | 4 10 9 8 | 6 | 30.1 15.7 27.1 18.8 26.9 18.0 | 23.7 23.1 22.3 | 24.9 23.1 22.3 | 1.3 | +30 | 5.5 5.4 7.4 | 2.5 2.8 3.0 | 4.4 4 | 1.3 1.4 1.3 | .24 . | +20 +35 | Gravelly eilt los | am Good | 5.0 5.0 | 3/48%;decomp.elow;mull str 18 %;mull-like structure | M-Approx.20% WP; good egri.soil, formerly cultivated. P-Pruned to 8'-9' about 1937.01d pasture. P-Unpruned. Formerly cultivated. |
| | 70 Sc 14 Sc | otch pine | Polk | Venango | 1400 | 15 | 5 x 5 | 20 | 90 | Good | 7 | 9 | 4 | - 1 | 6 3 | í | 21.0 12.9 | 17.7 | 18.8 | 1.2 | +20 | 4.8 | 1.6 | 3.4 3 | .7 | | +50 | Fine sandy loam | * Good | 5.5 | 1"-3/4"N; slow decomp. | P-abandoned farm; depleted fertility. |
| | 50 T | nite pine | Odin | Potter | 2000 | 31 | 4 x 4 | 20 | 90 | Good | - | 20 | - | - | 2 14 | 14 | 37.5 24.6 | | 31.4 | 1.0 | 0 | 8.2 | 3.3 | 6.2 6. | | | | Deep silt loam | Fair | 5.0 | 3/4"H, }" F;upper profile undeveloped. | P-Soil compact prior to plewing and planting. Some surface washing-exposed roots. |
| 3 | g n | nite pine nite pina | Forburg Condereport | Clarion Potter | 1150 2260 | 29 25 | 4 x 5 | 20 25 | 62 80 80 | Good Fair Fair | -6 | 6 25 | 5 | = | 4 7 | 14 | 33.1 13.5 31.9 22.6 | 27.4 26.8 23.6 | 30.1 26.8 23.6 | 1.0 | +10 | 5.2 5.0 | 3.7 | 5•3 6. 5•2 5. 4•0 4. | | .21 · | +31 | Silty clay loam Stony sandy loam | Fair Good | 5.0 5.0 6.5 | la"M,la"H;compact subsoil | P-Thinning needed. M-Considereril and snow denage |
| 7 | | hite pine | Coudersport Foxburg | Potter Clarion | 1800 1300 | 25 | 4 ± 4 5 ± 5 | 25 20 | 80 75 | Pair Poor | Ξ | න න | - | : | 9 11 1 8 | 14 5 11 | 29.2 19.1 28.0 20.4 | 23.8 | 23.6 23.8 | 1.0 | 0 | 6.0 8.6 | 3.7 2.2 3.0 | 4.0 4. 5.1 5. | .1 | | +31 | Stony silt loam Silty clay loam | Fair Good | 6.5 5.0 | 3/4"H;earthwn.sull:lt. B 3/4"H,undev.profile,lt.B | M-Heavily weeviled; pruning, thinning needed. M-Heavily weeviled; old field planting; subsoil slightly |
| | | ite pime | Condersport | Potter | 1720 | 24 23 | 5 x 5 | 10 10 | 80 85 | Good Excellent | _ | 10 10 | - | - | 7 3 | - | 26.6 15.0 32.2 26.0 | 23.2 | 23•2 29•4 | 1.0 | 0 | 4.5 6.3 | 2.3 3.8 | 3.5 3 5.0 5 | 5.5 i.0 | .15 - | | Fine sandy loan | V.Good Good | 4.8 | 3/4"#,3/4"F,1/4"H 1"#; leose,deep sull | mottled. If to 5 SP, approximately. Light weaviling. M-Fertile agricultural soil |
| | | nite pine nite pine | Girard Franklin | Erie Venango | 937 1 30 0 | 18 to 22 | 6 1 6 | 20 | 10 | Good | - | - | - : | 20 1 | 12 8 | - | 13.0 - | - | - | 1.3 0.6 | +30 | - | - | - | - | - | - | Fine loam | Good. | | Lt.L.; earthwn. mull | N.Lt. oak overstory:reinforement plantings gurrently. |
| | | hite pine | Hartetown Condersport | Crawford Potter | 1152 1700 | 23 23 | 5 x 5 | 10 15 | 8 0 75 | Fair Poor | - | 10 14 | ī | : | - 8 4 8 | 2 | 26.6 21.6 28.1 19.6 17.8 6.2 | 24.5 22.3 14.6 | 24.5 | 1.1 | +10 | 6.7 8.9 | 3.9 2.4 | 5.0 5 3.9 3 | i.0 3.3 | .22 .14 .14 | +38 -13 | Silty clay loam Gravelly loam | Good V. Good | 5.0 4.8 | lt" N.1" F and t" E 1"N, 1" H. no V. B 1"N; upper profile undev. 1" N;upper profile undev. | Growth rate based on whorl count and height. M-Acid (pH 4.0) litter, roosting bird lujury. M-Ros-by-row mir. EL, Fp, W., HS.Heavy weevil. |
| | ić w | hite pine | Cooperatown Foxburg | Venango Clarion | 1424 1150 | 22 | 5 x 5 4 x 6 4 x 6 | 25 18 | 75 87 78 | Fair Excellent | . 6 | 14 16 11 | i | | 1 13 15 2 | 11 1 | 17.5 6.2 28.9 20.5 22.1 13. | 25.3 19.0 | 22.3 15.5 25.5 | 0.7 1.1 | -30 +10 | 4.1 6.0 | 2.5 | 2.7 3 4.2 4 | .0 | .14 | -13 +19 | Fine sandy loam | Good Good | 5.0 | 3"H; upper profile undev. 1" H;upper profile undev. 3/4" H,2"F, 1" H | P-Heavily weeviled. M-1 WP to 5 SP approximately. |
| | 13 1 | hite pine | Polk | Venango | 1150 | 23 19 | 6 x 6 | 20 | 58 | Fair | - | 1 | 19 | • | 3 8 | 9 | 22.1 13.1 | | - | - | - | 5.1 | | 3.1 | - | - | | Fine sandy loam | Good | 4.5 | 3/4" 1,2"7 , 1" H | N-Good decomp of litter; formerly pastured. |
| | | itch pine itch pine | Coudersport Girard | Potter Brie | 1 6 00 937 | 24 23 21 | 4 x 4 | 25 10 | 80 85 84 | Good Good V.Good | - | 22 10 | 3 | Ξ. | 1 9 | | 27.9 22.1 26.9 19.4 | 29.8 26.0 22.6 | 30.3 26.0 22.6 | 1.3 | +1 8 0 0 | 6.2 5.5 4.3 | 3.9 4.0 2.6 1.2 | 6.1 6. 5.0 5. 3.8 3 3.2 3 | .0 | .22 | + 5 | Stony silt loam Fine sandy loam | Fair Good Fair | 5.8 | 3/4" N;earthwn sull 2"H,2"F,leose,deep mill 12" H,1" F, 2" H | M-Good decomp of litter; formerly cultivated, pastured. M-Fertile agricultural soil |
| | 25 P 68 P 14 P | itch pine itch pine | Kittanning Polk | Armstron Tenango | 1140 1160 | 19 | 5 x 5 | 50 50 | 86 | Good. | - | 19 20 | = | : i | 13 5 | 1 | 21.4 12.6 | 19.1 | 19.1 | 1.0 | - 9 | 2.3 | 1.2 | 3.2 3 | 3.2 | | | Silty clay loam Gravelly loam | Pair | 5.0 | 3"N,1"N,med.heavy V,H,B | P-Formerly cultivated; good decomp; slayey subsoil. P-Eather poor under-drainage. |
| | 62 J | ack pine ack pine | Eittenning Clee | Armstron Jefferso | n 1260 | 25 22 22 | 5 x 5 | 20 23 20 | 74 50 75 | V.Good Fair | 1 | 18 18 | 1 : | ر دو | ş 3 | 2 8 | 42.0 31.6 37.4 25.7 40.1 35.4 | 35.4 32.9 38.2 | 35.7 32.9 38.2 | 1.4 1.5 1.7 | - 7 | 7.2 7.7 8.3 | 3.0 1 4.1 3.4 | 4.6 4. 5.3 5. 5.3 5. | .7 | .24 | + 9 | Clayey silt loam Clayey silt loam | Poor | 5.0 5.0 | 12" H,2" F, 2" H 1" H, decomp, elow | P-Fairly rapid decomposition. Formerly cultivated. P-Tindbreak planting; stand conditions absent. |
| | | ack pine | Townwille Polk | Orawford | 1442 | 22 15 | 4 x 4 6 x 6 | 20 20 | 75 92 | Good Excellent | 2 | 18 16 | ō | • | 6 1.1 15 3 | 3 | 23.5 13.6 | | | | +13 | | | 5•3 5. 3•7 3 | .3 | .24 | | Fine sandy loam | V.Good | | 1" H, decomp. elow | |
| | | ap.black pine | Burning Well | Venango McKehn | 1390 | | 6 + 6 | 25 | 78 | 7.900d | | 12 | 8 | | 20 7 | 1 | 48.0 14.9 | 36.2 | 19.9 | | +20 | | | | -2 | | | Silty clay loam | Good Good | 5 0 | h'H, h'T, h'E.Very 1t.V | P-Decomp. fairly rapid. Formerly grand, P-Flanted on old log-lending. |
| | 149 15 | ersel shire | Burning Well Condersport | McKehn Potter | 1620 1720 | 33 33 25 | 6 x 6 | 25 20 64 | 70 60 | Excellent V.Good | 10 | 6 19 | 9 | _ : | 12 6 20 - | 1 | 32.4 15. 37.0 あ.0 あ.9 5.3 | 24.9 29.5 | 27.6 30.1 | 0.8 1.2 | -20 +20 -10 | 6.0 | | 5.5 5. 5.5 5. 1.7 1. | | .16 .23 | 0 | Stony eilt loam Stony fine loam | Fair V.Good | | h: decomp.slow h:: 3/4" E:med.V.B h::,2"F,12"E:mull strust. Grass sod,light V: no B. | P-Formerly pastured. M-Europe PH 6.0; spruss gall aphid 12juny. |
| | 41 # | orway spruce | Kittanning Coudersport | Armetron Potter | 2260 | නිතිත | % x 44 | 15 | 75 65 | V.Good Good | 2 | 11 16 | 2 | - 1 | 14 1 | - | 25.9 5.3 32.1 22. | 26.9 | 14.9 27.2 | 0.6 | +10 | 4.4 5.7 | 2.1 | 3.7 3. | .8 | | - 6 | Silty clay loam Stony sandy loam | 000d 000d | 5.0 5.0 | g" "; profile undeveloped | P-Formerly cultivated. L-Formerly cultivated. |
| | 46 🕱 | orway spruce | Forburg Condersport Condersport | Clarion Potter | 1300 1800 1700 | 25 | 2 = 2 | 20 | 40 60 80 | Fair Good Good | 3 | 16 10 24 | 1 | . : | | 1 | 32.1 22. 24.5 13.6 25.4 16.1 31.0 18.1 | 19.2 23.3 | 19.1 23.8 24.6 | 1.0 | -20 0 +10 | 4.5 | 2.4 | 3.4 3 | | .14 | -12 | Silty clay loam Stony silt loam Gravelly loam | Good Good V.Good | | 1"N;mull structure; lt. B 3/4" N;sarthwn.mull struct | M-Under-drainage fair. M-Formerly cultivated; part orchard. |
| | 28 | ormal shires ormal shires | Hartstown Girard | Potter Crewford Brie | | 23 22 23 | 5 x 5 5 x 5 4 x 4 | 25 20 10 | 40 | Good Excellent | - | 19 | 1 | - ' | 9 11 | ; | 28.3 18.2 32.6 18.9 31.8 16.6 | 22.1 | 22.4 | 1.1 1.0 1.2 | +20 | 4.5 5.4 4.1 | 2.1 2.1 2.5 | 3.3 3. | | .15 | - 6 | Silty elay loam Fine sandy loam | Good Good | 5.0 | 1"H, 3" F, 2" H | M-Formerly onlivestelpart orehard. Li-Destricted site. M-Outer former a site man alternate species. M-Ood agricultural soil. H-Many HS Anded out by ther confers. P-Steep could nest alope, formerly grands. P-Crowns closef, deminance well expressed. |
| | 18 \$ | orway spruce | Townwille Beaver | Crawford Beaver | 1 1442 1100 | 22 | 4 x 4 | 25 | 85 25 | Good Broellent | 5 | 20 10 | - | - | 20 L | i | 31.8 16.6 33.4 18.9 25.4 16.2 | 23.3 | 23.3 | 1.1 | +10 +10 | 4.9 | 2.1 | 2.8 2. | .8 .6 | .13 - | •19 -19 | Fine eardy loan Gravelly silt lm. | V.Good | 4.8 | h N, 2 F; 10000 mill struct. | M-Many NS shaded out by ether conifers. |
| | 7 1 | olara abirco | Polk | Asserta | 1100 | 23 18 | 5 x 5 6 x 6 | 20 20 | 92 80 | 7.Good | 7 | 7 | 6 | Ξ : | 20 - 19 1 | - | | | 25.2 | 1.3 | +30 | 4.2 | 2.0 | 3.3 3 | .6 | | 25 | Olayey silt loam | V.Good | 4.8 | 1-3/4"H; mill-like etrust. | P-Crowns closed; deminance well expressed, |
| | | eropeen larch hrepenn larch | Poxburg Coudersport | Clarion Potter | 1150 1720 | 31 25 | 6 x 6 5 1251 4 x 4 | 20 20 | 40 70 75 | Good Excellent | . 11 | 17 9 | : | - | 9 9 17 3 15 10 | 2 | 58.2 39.9 42.6 34.9 43.1 30.0 | 47.8 38.8 | 47.8 38.8 | 1.6 | + 7 +14 | 9.2 7.2 | 3.5 3.8 3.9 6.3 2.8 | 7.0 7. 5.5 5. 6.0 6. | .0 .5 | | #10 | Silt loam Stony fine loam | Fair V.Good | 5.0 5.0 | 1 L, 1 H; light V 1 HF, 2 H 2 H, 1 H, light B 1 H, 2 H: light V & B | M-Understocked, mixed EL and yellow poplar. M-Randon-row mixture, on steep south slope. |
| | Į, | hrepen larch hrepen larch | Inox Forburg | Clarion Clarion | 1320 1300 | 24 24 | 4 x 4 5 x 5. | 25 20 6 | 75 25 | Excellent Excellent | 1 | 15 | : | 20 1 | 15 10 | ° - | 43.1 30.0 53.0 35.6 34.126.2 | 39:3 | 39.3 46.7 30.2 | 1.6 2.0 | +14 | 7.2 9.8 9.9 | 3.9 6.3 | | .7 . | .32 + | 60 | Clayey wilt loam Silty oley loam | 000d 000d | 5.0 5.0 | 1" N, 1" H, light B 1" N, 2" H light V & B | M-EL scattered among poor WP. P-Slightly mottled subsoil. |
| | - | aropean larch | Condersport | Potter Potter | 2260 1600 | 24 24 | 4 x 49 | 20 | 5 60 | Fair Good | 3 | 17 | - | - | 2 4 19 1 | - | 37.2 26.2 | - | 32.6 | 1.4 | - 7 | | | 4.0 4 4.0 4 | | | - | Stony sandy loam Stony silt loam | 000d 000d | 5.0 | (See WP plantation-#79) | M-Only a few scattered EL have survived competitions dominated by WPin the alternate rows. |
| | | hropens larch | Condersport Condersport Townville | Potter Crawford | 1720 | 23 | 2:2 | 25 | 60 | ₹.Good | 2 | 23 | : | | 21 2 11 7 | 2 | 35.4 22.1 40.6 26.9 | 26.7 35.6 | 26.7 35.6 | 1.2 | -14 | 5.9 8.5 | | | .9 | .17 - | -15 | Gravelly loam | V.0001 V.0001 | 4.8 | 3" N, 3" H; no V, B 3"N, 3"F; hwy.hdwd.reprod. | M-Low initial survival; excellent subsequent growth. M-Alternate rows of RP, WP, WA and MS. |
| | | hropens larch hropens larch | Polk | Venango | | 22 18 | 6 ± 6 | 20 20 | 30 70 | V.Poor | 15 | 5 | 15 | : | 11 3 | é | 24.4 7.8 | 16.6 | 23.4 | 1.3 | - 7 | 3.7 | 0.7 | 2.0 3. | .0 | | 20 15 | Pine sandy loam Pine sandy loam | 000d | 5.0 | ht.F;ned.to heavy V | M-Survival limited to edges of mixed plantation. P-Marrow strip, suppressed by adjoining SP, |
| | 31 1 | hropesn larch | Yatesboro | Armstro | | 26 | 6 x 6 | 20 | 60 | Good | 2 | 18 | - | | 11 8 | 1 | 18.4 13.0 | | 15.5 | 0.6 | | | | 2.1 2 | | .08 - | 60 | Clay loam | Good | 5.0 | Very light N; earthworn sull; light B and V | Hard compact subsoil. Formerly grassd. P-Formerly cultivated, grassed. Rather open stand. |
| | | epaness larch | Reynoldsville | | | 24 | 6 x 6 | 20 | <i>2</i> 5 | Good wh. | | - | - | | 20 _ | - | 37.6 20_7 | - | 29.5 | 1.2 | | | - | | | • | | Silty elay loam | Fair | 5.0 | Lt. sod, heavy B, V, earthwn. | P-Low initial survival (probably frost); severa glass damage (Mar. '59); uninjured trees making good growth. |
| | 6 3 | apanece larch | Condersport Eittenning | Potter Armetron | 1720 1140 | 19 16 | 5 x 5 5 x 5 | 25 20 | 85 78 | Excellent Excellent | 16 | 9 20 | : | Ξ ' | 22 1 8 11 | 2 1 | \$0.0 25.0 32.1 22.1 | | 33.2 27.2 | 1.7 | +12 | 7.6 4.8 | 2•9 2•7 | 5.4 5 3.7 3 | 3.7 | .23 - | | Oravelly loam Silt loam | ₹.Good Good | 4.8 5.2 | struct.,high fertility \$" H, \$" H;fair decomp. 1" H, good decomposition | M-Planted in plessed counter-wise furroup. R-Formerly cultivated. Basal erook prevalent. |
| | 30 A | rbor Vitae | Hartetown | Orawfor | 1152 | 22 | 5 × 5 | 4 | 5 | Failure | - | - | 4 | - | - 4 | - | 18.8 15 | 16.7 | - | - | - | 2.7 | 2,1 | 2.4 | - | - | - | Silty clay loam | Good | 5.0 | (See WP plantation-#27) | M-Failure due to competition of other conifere. |
| | 57 6 | tugar ample | Condersport | Potter | 1750 | 42 | 16 x 20 | 25 | 95 | ₹.Good | - | - | - | 25 | . 21 | . 4 | 43.0 24. | - | 32.0 | 0.8 | - | 5. 0 | | 5.1 5 | 5.1 | .13 | - | Gravelly loam | V. Good | 4.8 | Grass sod | P-Stand not yet closed. |
| | • | cllow poplar | Forburg | Clarion | - | 30 | 6 x 6 | 16 | 140 | Good. | 4 | 12 | - | - | 4 12 | - | 54.0 35.0 | | | 1.6 | - | | | - | | .18 | | Silt loam | Fair | | å" L.}-å" H;Light V | M-Understooked mixed stand; EL and yellow poplar. |
| | | hite ash hite ash | Ocudersport Condersport | Potter Potter | 1700 1700 | 24 22 | 5 x 5 (6) | 11 30 | 70 60 | Fair Poor | - | 11 | = | 5 0 | 1 5 | 30 30 | 32.0 20. 25.8 8.1 | 25.2 17.2 | 25.2 17.2 | 1.0 0.8 | +11 -11 | 4.2 3.1 | 2.0 0.6 | 2.8 2 1.9 1 | 2 .8 1 . 9 | .12 + | | Gravelly loam Gravelly loam | V.000d V.000d | 4.5 4.5 | l H,l E, no V, B Grass sod | M-WP in admixture. Closed stand Border row; stand conditions absent. |
| | 59 N | led oak | Condersport | Potter | 1700 | 16 | (6) | 7 | - | 0004 | - | - | - | 7 | 7 - | - | 37.0 19. | 28.9 | 28.9 | 1.8 | - | 7.3 | 2.6 | 4.9 4 | ••9 | .31 | | Gravelly loam | V.Good | | Grass cod | - Local seed in a border row; stand conditions absent- |
| | 35 B | lack locuet | Pozbarg | Clarion | 1150 | 8 0 | - | 20 | 10 | Poor | - | - | - | 20 | 4 12 | . 4 | 92.0 | 74.5 | 74.5 | 0.9 | - | 19.9 | 6.5 1 | 2.5 12 | 2.8 | .16 | - | Fine sandy loam | ħir | 5.0 | 1º L, 12º H, Lt.V, medium to heavy briars & B, - lt.hdwd.&EL reproduction | P-Many thrifty individuals, but stand as a whole is under- stocked, poor. Occasional cutting for eil rigging. Borer injury. |
| | 10 B | lack walsus | Reynoldsville | Jeffere | on 17 5 0 | 31 | 6 x 6 | 8 | - | Poor | - | - | 3 | 5 | | 8 | 39. 0 31. | 5 34.2 | 54. 2 | 1.1 | - | 9.6 | 7.8 | 8.7 8 | 5.7 | .28 | - | Stony (shale) lm | . Good | 5.0 | - | P-Suall remant group; heavy mut erope. |

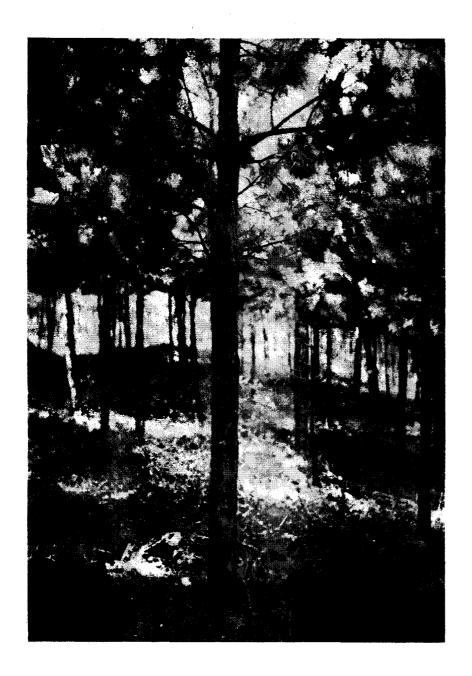


Fig. 4 Japanese black pine (Pinus Muhlenbergh) planted in 1915 at Polk State School, Polk, Pa. (See Plot #15).

Fig. 5 Black locust planted in 1860 on the Fox Estate, near Foxburg, Pa.



Fig. 6 Scotch pine (left) and red pine (right) in very poor condition.Direct cause undetermined; small bark beetles (Pityophthorus sp.), aphis, and secondary fungi present; no evidence of injury by parasitic fungi or spittle bugs. Fox Estate plantations, near Foxburg, Pa.



Fig. 7 Average diameter of white pines (left) is 3.1 inches; that of the red pine (right) is 5.4 inches. Planted 1922. Round-Top Plantations, Polk, Pa.



Fig. 8 Glaze-Damaged Japanese larch bordering open, wind-swept fields.
McCreight farm, near Reynoldsville, Pa. (See Plot #9).



Fig. 9 Severe localized snow-breakage in mixed plantation of Scotch pine and white pine on Guenter farm near Coudersport, Pa. (See Plots #39 and #40).



Fig. 10 An excellent plantation of Norway spruce, established in 1919 on the Engle farm near Beaver, Pa. (See Plot #11).

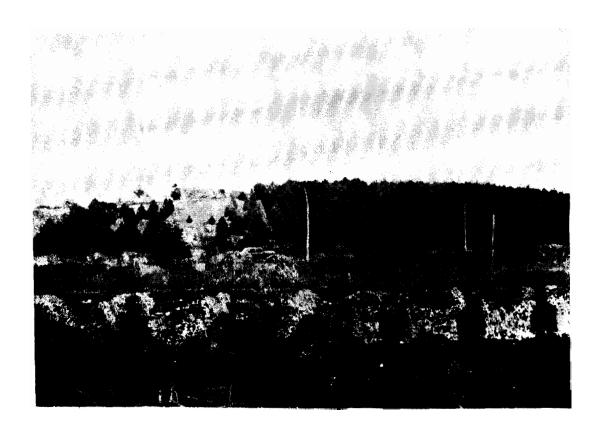


Fig. 11 Scotch pine (right) about 12 years old, on severely eroded and denuded west slope. Larch and red pine (left) only partial success.

Vegetation previously killed by fumes from ore furnaces (foreground). Near Sykesville. Ps.

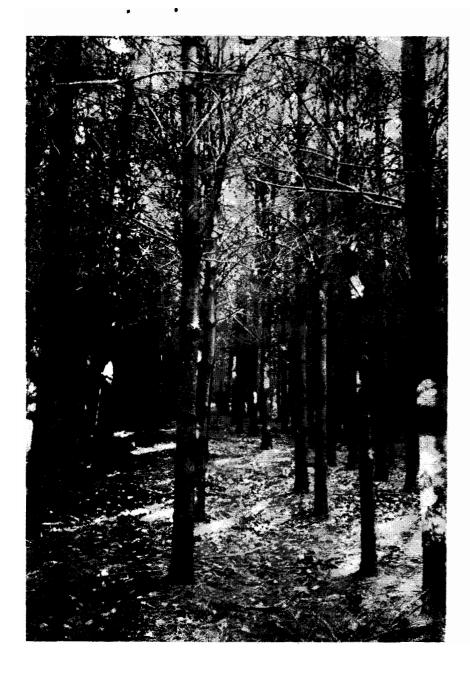


Fig. 12 Thrifty stand of white pine established in 1910 on the Bundy farm at Odin, near Coudersport, Pa. Very good recovery from weevil-injury (See Plot #50).



Fig. 13 Thrifty stand of pitch pine planted in 1920 on Nicholson Run area of the Allegheny River Mining Company, of Kittanning, Pa.

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